Examining Changes in Posttraumatic Stress Disorder Symptoms and Substance Use Among a Sample of Canadian Veterans Working with Service Dogs: An Exploratory Patient-Oriented Longitudinal Study

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RESEARCH

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ABSTRACT

Comorbid posttraumatic stress disorder (PTSD) and substance use (SU) is a growing health concern among Canadian veterans. Veterans are increasingly seeking symptom relief for PTSD and comorbid SU by engaging service dogs (SDs). Despite promising results, the efficacy of SDs in aiding veterans warrants further investigation. An exploratory patient-oriented, longitudinal, time-series, mixed-methods research design was employed with a sample of five Canadian veterans matched with SDs from AUDEAMUS, Inc. PTSD and SU were measured at six time points over 1 year with the Posttraumatic Stress Disorder Checklist for the *Diagnostic and Statistical Manual for Mental Disorders*, 5th Edition (PCL-5), Drug Use Screening Inventory Revised Substance Use Subscale (DUSI-R SU), and one-on-one semi-structured interviews. There were clinically significant decreases in the veterans' PTSD scores with the PCL-5. Interview content complemented these results. Veterans offered accounts of ways in which their SDs directly supported and helped manage their PTSD and related symptoms. While DUSI-R SU scale changes were non-significant, during interviews each veteran reported a decrease in their use of opioids and alcohol, while some reported an increase in their use of medical cannabis. However, veterans also highlighted ways in which their SDs sometimes contributed to increases in their PTSD and related symptoms, as well as their SU. This was particularly evident during the early stages of training and bonding. This study makes an important contribution to the emerging field examining the potential benefit of SDs for veterans diagnosed with PTSD. Additionally, this study is novel in its identification of the SDs beneficial contributions to veterans' comorbid problematic use of substances.

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Veterans Affairs Canada (VAC; 2006) defines an operational stress injury (OSI) as "any persistent psychological difficulty resulting from operational duties performed while serving in the Canadian Forces (CF) or as a member of the Royal Canadian Mounted Police (RCMP)" (p. 1). Similarly, the Canadian Institute for Public Safety Research and Treatment (2018) defines OSI as "any mental disorder or other mental health condition resulting from operational stressors (psychologically traumatic events or severe elements of occupational duties) experienced while serving in a professional capacity, especially in military or other public safety professions" (p. 1). Encompassed within the term OSI is a wide range of psychological conditions, including anxiety, depression, and posttraumatic stress disorder (PTSD). PTSD is generally understood as a "trauma and stress-related disorder" and has been defined as a "psychological response to the experience of intense traumatic events, particularly ones that are life threatening" (American Psychological Association [APA], 2013; VAC, 2017). PTSD is a growing health concern among Canadian veterans (Thompson et al., 2016). Recent estimates indicate that around 15,000 Canadian war-service veterans and members of peacekeeping forces have received a PTSD diagnosis (Rebeira et al., 2017). Potentially psychologically traumatic events (PPTE) in a military context include direct combat duties and being in dangerous war zones (Carleton, et al., 2020). However, veterans may also develop a mental disorder from PPTE exposures prior to or after service (e.g., violent crime victimization, surviving an accident, natural disaster), which can compound with service scenarios and increase risk for PTSD (Carleton, et al., 2020).

There are four main PTSD symptom categories as outlined in the *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edition (DSM-5): intrusive thoughts, avoiding reminders (avoidance/numbing), negative thoughts and feelings (pessimism), and arousal or reactive symptoms (APA, 2013). These symptoms can present variously for veterans. *Intrusive thoughts* can include involuntarily re-experiencing a traumatic event, often in the form of involuntary memories, flashbacks of traumatic events, or nightmares/distressing dreams (APA, 2020). People with PTSD may *avoid reminders* of their trauma, which can include people, places, activities, objects, situations, or circumstances that resemble or are associated with the event and bring on distressing memories (APA, 2020). Individuals may avoid discussing the traumatic event or their feelings around it (APA, 2020). In some cases, rumination can occur including thinking about how one could have prevented an event or even how revenge or justice can be achieved (APA, 2013). *Numbing thoughts and feelings* may express as distorted beliefs about oneself or others, as a loss in interest of normal activities, flat affect, feeling detached from loved ones, ongoing fear, horror, anger, guilt, or shame (APA, 2020), and even *pessimism* about or difficulty imagining a future (APA, 2013). *Arousal and reactive symptoms* can present as anxiety, increased arousal, hypervigilance, exaggerated startle responses, behaving recklessly or in a self-destructive way, irritability, angry outbursts, difficulty concentrating, and sleep problems (APA, 2013). In addition to all or a combination of these symptoms, veterans with PTSD may also present with relational problems, social avoidance, employment difficulties, physical health problems, legal difficulties, homelessness, depression, and suicidal ideation (Whitworth et al., 2019; Yarborough et al., 2017). Furthermore, PTSD has a strong association with elevated risks of suicide, depression, substance use, and homelessness (Stander et al., 2014; Wisco et al., 2014).

TREATING PTSD

Veterans rarely seek mental health services (Hoge et al., 2014) and dropout rates for those who do seek treatment for PTSD are around 50% (Schottenbauer et al., 2008). Potential reasons for dropout and/or poor participation in treatments among veterans include: (a) the need for a high number and lengthy duration of intervention sessions; (b) desire to not be seen as "weak" by seeking treatment; (c) avoidance and/or denial of trauma experiences; (d) poor therapeutic relationships between veterans and clinicians; and (e) desire to not include PTSD diagnosis/treatment in formal records (Fragedakis & Toriello, 2014). Stigma related to mental health issues in the military can also create barriers to help seeking and delay treatment for PTSD among veterans (Dell et al., 2017; Hoge et al., 2014).

Veterans with PTSD are increasingly seeking out relief for their symptoms by engaging service dogs (LaFollette et al., 2019; Whitworth et al., 2019). A service dog (SD) is specifically trained to perform a variety of tasks for people with physical, sensory, neurological, developmental/cognitive impairment, or other daily challenges, including PTSD (LaFolette et al., 2019). SDs are trained to assist with PTSD symptoms by performing specific behaviors or tasks tailored to individual needs (Whitworth et al., 2019). There is growing empirical evidence about benefits of SDs in assisting veterans to address their PTSD symptoms, including mitigating physical challenges, decreasing symptoms of depression, and improving quality of life, emotional health, and interpersonal relationships (Husband et al., 2020; O'Haire & Rodriguez, 2018; Vincent et al., 2017; Yarborough et al., 2017). Veterans also report improved well-being, increased feelings of calm, more positive affect, and lowered feelings of hyperarousal, anxiety, and hypervigilance while working with SDs (Knisley et al., 2012;

Stern et al., 2013). In a recent Canadian-based study, researchers found that compared to a waitlist control group, participants in the experimental condition experienced: (a) significant decreases in nightmares, improved sleep, improved physical activity; (b) decreased PTSD symptoms; (c) decreased depressive symptoms and medication use; and (e) improved social integration in the community and comfort being in public and commercial places (Vincent et al., 2018). Given the increase in promising results in this emerging field, the efficacy of SDs in aiding veterans with their PTSD warrants further investigation.

Many veterans with PTSD also have an increased risk for developing substance use problems (Banducci et al., 2016; Bowe & Rosenhack, 2015). This correlation has been explained by high rates of prescribed medication use/misuse (e.g., opioids) as well as the use of other licit (e.g., alcohol) and illicit (e.g., cocaine) substances to cope with PTSD symptoms (Butler & Taylor, 2015; Harnish et al., 2016). Among Canadian veterans, a recent report suggests that more than half of men and more than a quarter of women with PTSD problematically use alcohol and drugs (VAC, 2017). Some evidence suggests that male veterans are more likely to have a comorbid diagnosis of PTSD and substance use disorder compared to female veterans (Cribbs, 2017). Alcohol misuse (i.e., drinking above recommended limits) and cigarette smoking are reportedly the most prevalent types of substance use problems among male and female veterans (Hoggatt et al., 2017). Alcohol is still commonly accepted as part of Canadian military culture, making problematic use more difficult to identify (Gibson et al., accepted November 2020; Richer et al., 2016). Further, alcohol use can increase the risk of interpersonal violence, poorer physical and mental health, and mortality (Bridevaux et al., 2004).

An increase in the misuse of prescription drugs, such as opioids, has been reported among veterans to address conditions such as migraine headaches and chronic pain (Macey et al., 2011; Wu et al., 2010). Compared to veterans without a mental health diagnosis, those with a PTSD diagnosis are more likely to receive opioid prescriptions and to receive higher doses of opioid medications (Seal et al., 2012). Misuse of opioids has been correlated with a variety of adverse outcomes, including inpatient or emergency room admissions, opioid-related accidents and overdoses, and violence-related injuries (Bohnert et al., 2014; Seal et al., 2012). Cannabis is another commonly used substance among veterans (Bonn-Miller et al., 2012). One report indicated that cannabis use among one sample of veterans increased just over 50% from 2002 to 2009 (Wagner et al., 2007). The impact of SDs on veterans' comorbid PTSD and substance use has not been studied to date.

The current project was designed to examine whether AUDEAMUS, Inc. SDs assist veterans with managing PTSD symptoms and addressing problematic substance use. More specifically, this research was intended to examine the complementary role of SDs (O'Haire & Rodriguez, 2018) and potential contribution they made to PTSD symptom and substance use changes for the veterans (Mayne, 2008). The project was also designed to address some of the criticisms of research related to SDs, including lack of long-term follow-up studies, limited data collection, lack of quantitative measurement, and observation in unnatural settings (Herzog, 2014; Marino, 2012). AUDEAMUS, Inc. is a national holistic SD training program for Canadian military veterans who suffer from OSIs, including PTSD. Working with one SD program allowed for as much consistency in training approach and veteran experience as possible.

SUMMARY OF SD MATCHING AND TRAINING

AUDEAMUS, Inc. matches veterans with dogs and provides hands-on training for the veteran handler SD dog team. Stage 1 of the AUDEAMUS, Inc. training model involves assessing an applicant's needs (mental and physical) and capabilities with respect to caring for and training a SD, examining the compatibility between the applicant and dog, and completing a behavioral assessment of the dog to ensure they are suitable for SD training. In Stages 2 and 3, AUDEAMUS, Inc. trainers assist handler/SD teams with learning basic obedience skills using positive reinforcement (e.g., sit, stay, down, leave it, heal, touch), engaging/connecting as a team (i.e., forming a bond), preparing for public access, as well as understanding the importance of emotional regulation and recovery for safety and security in all situations. Stages 4 and 5 involve training for public access requirements and SDs are taught more specific skills to meet their handler's needs (e.g., detection, response, alertness, mobility, hypervigilance, anxiety, interruptions). In Stage 6, teams must build on the skills taught in previous stages and demonstrate skills required for full public access. Handler/SD teams can obtain certifications following each stage upon showing evidence of possessing the necessary skill sets. As a veteran-centered program, each handler/SD team determines their training schedule and timeline to complete each training stage. It is important to point out that each veteran has a unique experience with training and it fluctuates between accomplishments and challenges.

METHODS

PARTICIPANTS

Veterans included five males with a mean age of 43 years (range 36–51 years) who provided a full year of research data. Two veterans self-identified as Métis,[1] two as Caucasian/white, and one as First Nations.[2] All veterans had

at least some college- or university-level education. Most of the veterans (n = 4) grew up with pets, some with dogs (n = 3). At the beginning of the project, two veterans did not have any household pets. Among the other three veterans, one individual had two dogs (one of which became his first service dog), another had two cats and two dogs, and the third had one lizard and one cat.

Three veterans were matched with dogs through AUDEAMUS, Inc. Working with one SD supplier allowed for some consistency in the participant experience and had no bearing on how the research project was implemented. The other two veterans trained a family dog. Around the 6-month time point, one veteran accepted limitations of their SD in training (i.e., dog's anxiety and limb injuries) so it was retired as a family pet and replaced through AUDEAMUS, Inc. Another veteran requested a female dog around the same time point and was subsequently matched with a female SD by AUDEAMUS, Inc.

Participating veterans reported 4.5 to 34 years of service with either the Canadian Military or Navy. At the beginning of data collection, four veterans were on medical leave or retired and one retired at the 9-month time point of the project. Each veteran had a different injury/PTSD source and development date. Potentially traumatic events included being abducted, watching a close friend die in a bomb explosion, being sexually assaulted, and suffering a severe injury during combat. The PPTE exposures and PTSD development occurred on average 21 years ago for the veterans (range = 11 to 35 years). All veterans self-identified having a history of problematic substance use, defined as "use of drugs or alcohol in a harmful way that has negative effects on one's health and life" (Government of Canada, 2019). None of the veterans were in active, serious addiction at the time of research participation such that there would be ethical concerns with them working with SDs.

Throughout the research, each veteran reported experiencing diverse challenging life circumstances. Some of the veterans moved to new homes, ended romantic relationships, dealt with family conflicts, suffered physical injuries, managed illnesses/chronic health conditions, and accessed medical treatment for their SDs (e.g., allergies). Each veteran underwent a variety of physical and mental health treatments over the course of the year, such as physical rehabilitation, medication changes, written exposure therapy for trauma, Operational Stress Injury clinic programs, counseling sessions, psychiatric sessions, as well as group cognitive-behavioral therapy sessions for pain management and trauma. This was similar to their experiences prior to taking part in the research, with various attempts at coping with their PTSD symptoms and the concerns they posed, personally and within their communities. Further, it is common for veterans to approach a SD organization when traditional treatment options are not aiding them in adequately managing their PTSD symptoms.

PROCEDURE

An exploratory (Stebbins, 2001), patient-oriented (Mallidou et al., 2018; Strategy for Patient-Oriented Research, 2019), within-subjects (Charness et al., 2012), longitudinal (i.e., 1 year of data collection; Ployhart & Vandenberg, 2010), time series (i.e., six data collection points; Salkind, 2010) mixed-methods research design was employed to allow for repeated observations of the constructs of interest for each veteran as well as identification of causal estimates (Charness et al., 2012). This design afforded researchers the opportunity to train SDs side-by-side with the veterans to gain their trust and learn what they endure. The human and animal Research Ethics Boards at the University of Saskatchewan each approved this research [17–317 and 20170114].

The process for recruitment involved a representative of AUDEAMUS, Inc. examining their immediate waitlist of veterans diagnosed with PTSD, determining who had self-identified concerns regarding problematic substance use (primarily opioids), approaching six veterans who met the inclusion criteria, and having the veterans agree to participate. One veteran dropped out in the third month of data collection due to personal reasons unrelated to the study. Lack of agreement to participate in the research project had no bearing on whether a veteran received a service dog and was supported by AUDEAMUS, Inc. Research participation inclusion criteria were: (a) have a formal diagnosis of PTSD as determined by each participants' mental health professional outside of the research group; (b) struggle with PTSD enough to have requested participation in AUDEAMUS, Inc.; (c) problematically use at least one substance (primarily opioids; self-identified concerns); (e) have a mental health professional agree to their participation in the research project and work with the veteran during the project; and (f) have a suitable family pet to train or be matched with a dog through AUDEAMUS, Inc. Mental health professionals ensured AUDEAMUS, Inc. that participating veterans' PTSD symptoms were not severe enough to jeopardize any SD's welfare.

Veterans were informed about the study in-person by the lead researchers then read and signed consent forms. Data collection took place at six time points from May 2018 to May 2019: baseline, and 1, 3, 6, 9, and 12 months. At all but one time point (at 9 months the team could not meet in-person due to poor weather conditions impeding travel), veterans convened on average for 3 days in Saskatchewan with the research team to complete the data collection

and simultaneous training with AUDEAMUS, Inc. Data collection occurred over a 3-day period to accommodate the veteran's various PTSD and other physical health concerns (e.g., poor concentration, need for movement). Outside of the meeting times, veterans continued with AUDEAMUS, Inc. training remotely with the SD trainers.

PTSD symptoms were measured with the PTSD Checklist (PCL-5) and substance use was measured with the Drug Use Screening Inventory (DUSI-R) Substance Use (SU) subscale. Semi-structured interviews were also conducted at each time point with the veterans, primarily in-person (one was done by telephone) to examine veteran reports of their PTSD and substance use experiences as well as the relationship with their SD. Interviews were 30 to 60 minutes in length and conducted by two of the primary researchers, one a social worker and the other an addictions specialist, who also completed the AUDEAMUS, Inc. service dog training alongside the veterans with their dogs to develop rapport with the veteran participants and gain insight into their experiences with their SDs. The use of quantitative measures and in-depth interviews allowed for data triangulation (Heale & Forbes, 2013).

MEASURES

PCL-5

The PCL-5 is a 20-item self-report measure for assessing DSM-5 symptoms of PTSD (APA, 2013; Weathers et al., 2013). Veterans were asked to select an index trauma (i.e., single worst traumatic or most distressing event, or event currently causing the most distress) to rate their symptoms within the past month using the PCL-5 items (Carleton et al., 2020). Self-report ratings are on 5-point Likert-type scale ranging from 0 "*not at all*" to 4 "*extremely*." Meeting the minimum clinical criteria for each PTSD cluster and obtaining a total score of >32 is indicative of a positive screen for PTSD (Carleton et al., 2020; Weathers et al., 2013;). Further, a 5- to 10-point change represents reliable change and a 10- to 20-point change represents clinically significant change (Weathers et al., 2013).

DUSI-R

The DUSI-R measures 10 domains (e.g., psychiatric disorder, work adjustment, peer relations) to identify potential consequences of alcohol and drug use. For our current analyses we examined only the DUSI-R SU subscale. Substance use is measured with 16 items related to desire for or dependence on alcohol/drugs, context of alcohol/drug use, behavior while under the influence of alcohol/drugs, and outcomes resulting from the use of alcohol/drugs. The response scale is dichotomous ("*yes/no*").

The PCL-5 and DUSI-R SU were analyzed by a researcher outside of the project using descriptive statistics and reliable change index (RCI; Jacobson & Turax, 1991). Jacobson and Truax (1991) describe RCI as a statistic for determining whether a change in an individual/group's score is statistically significant based on a scale's test-retest reliability (e.g., Cohen's D). RCI signifies the likelihood that a change in test scores is the result of "true" or "reliable change" or "results from chance" (Hensel et al., 2007). In cases where sample sizes are small (i.e., ANOVA is not appropriate), population-based information is unavailable, and concerns about practice effects on scores through repeated testing are not present the use of RCI is the most appropriate statistic to employ (Atkins et al., 2005; Maassen, 2004). Interviews were transcribed by a neutral transcriber outside of the research team and then independently analyzed using Saldaña's (2013) content analysis coding guide by two researchers outside of the project for reliability. The guide was selected due to the preliminary and non-theory-development driven nature of this study (Saldaña, 2013).

RESULTS

PTSD SYMPTOM CHANGES

For the PCL-5, individual scores and group means for all six time points (May 2018 to May 2019) are reported in ***Table 1***. At baseline, four veterans met the PCL-5 criteria for a positive screen of PTSD and at the 1-year time point, three veterans screened positive for PTSD. Individual and groups means fluctuated over time, with clinically significant increases and decreases. Sample mean scores for the PCL-5 decreased by 12.1 from baseline to 1-year, suggesting a reliable and clinically significant change overall (Weathers et al., 2013). Comparing group mean scores on the PCL-5 for Time 1 to Time 6 the RCI value was –1.89 (***Table 1***), which did not meet the –1.96+ cutoff to signify a statistically significant difference between the scores (Jacobson & Truax, 1991).

INTERVIEW RESPONSES REGARDING PTSD

Veterans reported variation in their experience of PTSD and expression of symptoms. Some individuals reported experiencing symptoms from all four PTSD categories (intrusive thoughts, avoidance/numbing, negative thoughts/feelings, and arousal or reactive symptoms), while others only expressed symptoms from three of the four categories. With respect to intrusive thoughts, the veterans commonly reported having nightmares, bad dreams, or "intrusive memories." Reported avoidance/numbing-related symptoms included self-isolation, low/restricted socialization, avoidance of public spaces, trust issues with others, and obsessive-compulsive tendencies. Commonly reported negative or numbing thoughts/feelings-related

	TIME 1 MAY 2018	TIME 2 JUNE 2018	TIME 3 SEPT 2018	TIME 4 NOV 2018	TIME 5 FEB 2019	TIME 6 MAY 2019
	PCL SCORE	PCL SCORE	PCL SCORE	PCL SCORE	PCL SCORE	PCL SCORE
Veteran 1	**58 ***	**57***	38	**41***	28	44
Veteran 2	**72 ***	**73***	**57***	**66***	**70***	**63***
Veteran 3	**67***	**63***	**61***	**56***	**54***	**59***
Veteran 4	**68***	**58***	**51***	**52***	**44***	**37***
Veteran 5	36	11	24	8	14	9
	M(SD)	**M(SD)**	**M(SD)**	**M(SD)**	**M(SD)**	**M(SD)**
Group	60.20 (14.46)	52.40(24.00)	46.20(15.16)	44.60(22.33)	39.20(22.37)	48.10(19.22)
	TIME 1 MAY 2018 N = 5	TIME 2 JUNE 2018 N = 5	TIME 3 SEPT 2018 N = 5	TIME 4 NOV 2018 N = 5	TIME 5 FEB 2019 N = 5	TIME 6 MAY 2019 N = 5
Test-retest reliability (Cohen's D)	.902	.972	.927	.979	.986	.971
Standard error	6.40209	5.679437	5.792679	4.5762882	3.743217	4.628789
	TIME 1 VS TIME 2	TIME 2 VS TIME 3	TIME 3 VS TIME 4	TIME 4 VS TIME 5	TIME 5 VS TIME 6	TIME 1 VS TIME 6
Reliable change index	−1.3733756	−1.0916575	−0.27621071	−1.1799956	+2.377634**	−1.890008

Table 1 PCL-5 Individual Scores, Group Means, and RCI Analysis Values.

* All criteria met for positive screen for PTSD based on PCL-5 scoring (met minimum clinical criteria for each PTSD cluster and obtained a total score for >32).

Note: Veteran 5 did not meet the minimum clinical criteria for the PCL-5 cluster C at Time 1, cluster B or C at Time 2, cluster B, C, or E at Time 4, cluster B, C, or E at Time 5, and cluster B, C, D, or E at Time 6. Veteran 6 did not meet the criteria for cluster C at Time 3 and cluster B or C at Time 6. If the absolute value of the RCI is greater than 1.96, the difference in scores between the two intervals is statistically significant at a 95% confidence interval. RCI values signifying a significant increase in scores between given intervals are denoted by (**), and those signifying a significant decrease are denoted by (*).

symptoms included suicidality, struggles with negative affect, and hopelessness. The most common arousal/reactive-related symptoms reported included hypervigilance, anxiety, struggles with self-regulation, explosive anger, difficulties with focusing, aggressiveness, sleep problems, and hyperactive fight or flight response.

Over the 12 months, veterans described ways their SDs assisted in managing their PTSD. For *intrusive thoughts/feelings symptoms*, veterans reported their SDs waking them during nightmares. Some veterans appreciated this and slept better, while others found being woken led to overall fractured and unrestful sleep. Unwelcomed interruptions tended to be more of an issue with puppies compared to older, longer-trained dogs. None of the veterans reported ways in which their SDs supported them with managing intrusive negative memories.

> I don't have nightmares anymore because as soon as I start having a nightmare she wakes me and I get a tongue in the ear, nose, mouth, the eye whatever she decides to put it in and when I wake up and go back to sleep...So I don't have nightmares anymore and so therefore I get more sleep.
>
> **-Veteran 4 at 3-month time point, with older, more trained SD**

With *avoidance-related symptoms*, the SDs reportedly increased some of the veterans' physical activity levels by getting them outside, helped them reconnect with activities/hobbies they once enjoyed, gave them the capacity to leave their homes and engage in public settings, and helped them be more mindful and present-focused.

> I have been bringing her everywhere and I just told my daughters that is how life is and they have seen me with a dog and without a dog and they know that it is better to have my dog with me.
>
> **-Veteran 1 at 6-month time point**

Two veterans noted that while their SDs were briefly injured they ended up isolating themselves at home. Despite initial struggles with their SDs (e.g., dog's anxiety, veteran

concerns with having a male dog), they each reported feeling increasingly connected and bonded to their dogs over time. One veteran disclosed that the relationship with their SD was enough on its own and they did not need to connect with anyone else (i.e., other humans). Some of the veterans discussed the benefits of having a routine and sense of caring/responsibility with a SD, as well as the unconditional acceptance and bond they felt from the SD. Further, some of the veterans noted that they felt a connection and sense of belonging to the AUDEAMUS, Inc. group.

There were some examples of how the veterans perceived their SDs to support them with their *negative or numbing thoughts/feelings*. At baseline, the veterans expressed feeling hopeful that their SD would be able to aid them in addressing their PTSD symptoms. This level of hope decreased for some of the veterans part way through the project, particularly for the two individuals who relinquished their first SD and started working with a new one.

Hope also decreased for the veterans during times they struggled with physical ailments (e.g., chronic health conditions) or troubles at home (e.g., moving to a new home, conflict with children). However, levels of hope began to increase again for each veteran towards the end of data collection. Each veteran reported times that their SD reacted to them (i.e., jumped up, interrupted) during both excited and depressed emotional states.

Veterans reported ways in which their SDs aided in addressing *arousal/reactive symptoms*. When the veterans felt anxious, angry, agitated, stressed, or triggered their SD reportedly nudged, barked at, or jumped up on them, which helped them refocus, manage their emotions, or get back to the present time. The SDs' interventions and perceived support reportedly increased the confidence of the veterans to complete tasks on their own again, including driving. Two of the veterans disclosed that the SDs helped them manage their road rage because they could either regulate by petting the dog or focus on the fact that they care about and want to protect their dog. Beyond intervening when the veterans felt a negative emotion, they reported that the SDs helped them stay mindful, grounded, kept their minds preoccupied, and focused on something other than themselves.

However, there were occasions when SDs themselves were frustrating for the veterans and elicited feelings of stress, anger, depression, and led to them being triggered and less able to concentrate. Each veteran reported at some point being frustrated with having to train their SD and maintain a regular training schedule (as required with the AUDEAMUS, Inc. model). Negative public interactions with SDs sometimes resulted in the veterans feeling anxious, stressed, and embarrassed. The SDs sometimes solicited attention undesired by the veterans from people who wanted to interact and were curious about the dog. In all these negative instances, though, the SDs and veterans were often still developing their training skills and relationships, or the SD was not a good fit for the veteran's needs resulting in a new dog being acquired.

While there were times of improvement and various setbacks over the course of the year for all of the veterans, at the 1-year mark they each indicated that despite the highs and lows that they were hopeful for the future and on an upward trajectory. Two of the veterans expressed significant improvements to their lives, which they attributed to their SDs.

> [Dog] has completely changed my life about my PTSD so I am not thinking about my symptoms and I focus on [Dog] and not on my problems…I am not thinking about the problems I feel better for a different quality [of life].
>
> **-Veteran 5 at 1-year time point**

SUBSTANCE USE CHANGES

At baseline, each veteran reported a history of problematic opioid use and alcohol use. Each veteran had prescriptions for several medications to manage their anxiety, depression, panic disorders, sleep disorders, and/or other health ailments (e.g., irritable bowel syndrome, multiple sclerosis, diabetes). Three veterans had a prescription for opioids at the start, but only two reported taking them regularly while one indicated they had recently quit taking them and another had stopped using opiates 3.5 years ago. All veterans self-identified opiates being problematic in their lives, including those not currently using but at risk to. Two veterans regularly smoked tobacco cigarettes. Towards the start of the project, two of the veterans were regularly consuming medically prescribed non-synthetic cannabis (CBD for pain and THC for sleep), while the other three began to explore the use of medical cannabis closer to the middle and end of the data collection period.

Individual scores and group means for the DUSI-R SU subscale are in ***Table 2***. There were notable fluctuations in individual scores and group means over time. Comparing the sample mean scores from Time 1 to Time 6, there is a difference of 6.67 points. Comparing group mean scores on the DUSI-R SU subscale for Time 1 to Time 6, the RCI value was –0.49 (***Table 2***), which does not meet the –1.96+ cutoff to signify a statistically significant difference between the scores (Jacobson & Truax, 1991).

INTERVIEW RESPONSES ON SUBSTANCE USE

Over the course of the year, most of the veterans reported decreases in alcohol, tobacco, opioids, and anti-anxiety medication use and attributed these changes in part to

VETERAN	TIME 1 DUSI SU SCORE (%)	TIME 2 DUSI SU SCORE (%)	TIME 3 DUSI SU SCORE (%)	TIME 4 DUSI SU SCORE (%)	TIME 5 DUSI SU SCORE (%)	TIME 6 DUSI SU SCORE (%)
1	40	26.67	20	46.67	33.33	33.33
2	53.33	53.33	33.33	26.67	13.33	53.33
3	13.33	6.67	26.67	13.33	6.67	40
4	33.33	13.33	6.67	13.33	0	6.67
5	26.67	13.33	26.67	6.67	13.33	0
	M(SD)	**M(SD)**	**M(SD)**	**M(SD)**	**M(SD)**	**M(SD)**
Group	33.33(14.91)	22.67(18.62)	18.89(12.94)	21.33(15.92)	8.33(6.38)	26.67(22.61)
	TIME 1 MAY 2018 N = 5	**TIME 2 JUNE 2018 N = 5**	**TIME 3 SEPT 2018 N = 5**	**TIME 4 NOV 2018 N = 5**	**TIME 5 FEB 2019 N = 4**	**TIME 6 MAY 2019 N = 5**
Test-retest reliability (Cohen's D)	.576	.793	.491	.492	Negative average covariance among items	.848
Standard error	13.730159	11.980635	13.055941	16.046855	Could not compute	12.466294
	TIME 1 VS TIME 2	**TIME 2 VS TIME 3**	**TIME 3 VS TIME 4**	**TIME 4 VS TIME 5**	**TIME 5 VS TIME 6**	**TIME 1 VS TIME 6**
Reliable change index	−0.77839	−0.3155092	0.1868881	−0.810128	Could not compute	−0.485064

Table 2 DUSI-R SU subscale individual scores, group means, and RCI analysis values.

Note: Range of scores that can be obtained is between 0 to 100%. DUSI-R scores reflect gradations of severity. As such, cut-off scores for evaluation are not provided. If the absolute value of the reliable change index (RCI) is greater than 1.96, the difference in scores between the two intervals is statistically significant at a 95% confidence interval. RCI values signifying a significant increase in scores between given intervals are denoted by (**), and those signifying a significant decrease are denoted by (*). Further, there was a negative average covariance for Time 5, possibly due to the small sample size or there truly was a negative covariance among the scale items.

working with their SDs. As one veteran noted, "you are not going to care for a dog [while high]." Each veteran reported using medical cannabis at some point during the year, and by the end of the year many reported that they were using medical cannabis (either CBD or THC) instead of opioids for pain management, anxiety, and sleep support. Largely the veterans were consuming medical cannabis oils, though one individual consumed via smoking and another through vaping. While each veteran reported that they still drank alcohol, two reported only occasionally drinking a couple of drinks alone to combat loneliness, one only drank occasionally socially, one was drinking/binging a bit more socially since quitting opiates, and another had reduced their daily evening drinking routine from 7 to 5 days a week. One veteran who struggled with their first of two SDs reported an instance of increased drinking to manage their stress due to training with the dog. Three of the veterans were no longer taking opioids and a fourth had decreased his consumption. However, while the fifth veteran was still taking opioids for pain management, he expressed a desire to wean off them and instead rely solely on medical cannabis for pain (CBD) and sleep (THC).

> I am going to go and try and get medical marijuana because I would like to get off of some of these heavier drugs if I could and if that turns out to be a viable option that would be great.
>
> **-Veteran 2 at 9-month time point**

Concerning other prescriptions, one veteran was still taking prescriptions for anxiety, one had a prescription for an anti-depressant but was not yet taking it, one wanted to wean off his medications for anxiety and depression, and another had quit taking anti-anxiety medication and was weaning off his prescribed anti-depressant. Of the two individuals who reported smoking tobacco cigarettes, one had switched to vaping nicotine while the other was still smoking cigarettes and even perceived they smoked more due to regularly taking their SD outside.

> I still have pain but not at the same level and I reduced my pills consumption a lot and I am presently in the process to stop another medication and that is for depression, I don't remember the name and my consumption for opioids one or two

> times per week and that is it and practically stopped the cannabis except for sleep.
>
> **-Veteran 5 at 1-year time point**

DISCUSSION

The primary purpose of this exploratory research was to examine any changes in PTSD symptoms and substance use for veterans and the potential contributions (Mayne, 2008) to these changes resulting from working with SDs over the course of 1 year. This research was specifically designed as a contributing starting point in an emerging field and to address some common criticisms of SD-related research: lack of long-term follow-up, limited data collection, lack of quantitative measurement, and observations in unnatural settings (Herzog, 2014; Marino, 2012).

Decreases in the veterans' PTSD positive screen scores were clinically significant, despite not being statistically evident. In addition to providing contextual information about the veterans' experiences of PTSD and perceived changes over time, during interviews the veterans offered accounts of the ways in which their SDs directly supported them in managing their symptoms. In many cases, the SDs were trained to perform tasks which helped decrease many PTSD symptoms for the veterans, including nightmares, avoidance, and mood alterations. More often, having the SDs with them posed the most benefit for the veterans. For example, veterans reported how petting their SDs allowed them a chance to regulate their emotions, which can help decrease heart rate and anxiety (Bell, 2013; Kruger & Serpell, 2010). The SDs also gave the veterans confidence to get out of their homes and engage in public spaces; a stark contrast to self-isolating and oftentimes staying in their basements. These findings are consistent with the findings of others (LaFollette et al., 2019; O'Haire & Rodriguez, 2018; Whitworth et al., 2019; Yarborough et al., 2017), including Vincent and colleagues (2018), who reported decreases in both PTSD and PTSD-related symptoms (e.g., depression, improved physical activity, improved social integration). While there may be other potential explanations for these results (e.g., additional medical and mental health treatments), accounts from the veterans support the contribution to clinically significant and reported PTSD symptom changes (Mayne, 2008) and complementary nature of the SDs (O'Haire & Rodriguez, 2018). However, initially training and bonding with an SD, as well as having to navigate public spaces seemed to frustrate the veterans and trigger PTSD and related symptoms for them. Adequate training support as well as ensuring SDs are a good fit for veterans are key for ameliorating these issues.

While there were no statistically significant changes on the DUSI-SU scores, interviews with the veterans revealed that the use of specific substances (e.g., opioids) decreased. The DUSI-SU dichotomous scale may not have captured nuances in substance use-related behaviors (Krosnick & Presser, 2009). Further, this subscale may have been influenced by social desirability and comprehension issues (Krosnick & Presser, 2009). Each veteran linked change in their substance use to working with their SDs, but not to the same degree as with their PTSD symptoms. This may be because the SDs were not trained to specifically address substance use behaviors.

STUDY STRENGTHS AND LIMITATIONS

Employing a longitudinal, time-series study design was essential for capturing changes in the veterans' PTSD symptoms and substance use, which are complex and rarely static (Ployhart & Vandenberg, 2010). While a randomized-controlled trial or experimental design with a control group would have increased the internal validity (Mitchell & Jolley, 2012), the within-subjects design still allowed for the identification of causal estimates (Charness et al., 2012). Adopting a patient-oriented approach to this research was beneficial for two main reasons. First, engaging the veterans at all points of the research, from conceptualization of the project to methods and eventually knowledge dissemination, improves quality, relevance, and application of research findings (Morgan et al., 2014). Second, this design also afforded the researchers the opportunity to train SDs alongside the veterans to gain first-hand insight of what they endured and build veteran-researcher trust (Morgan et al., 2014). This study was also strengthened using mixed-data collection methods (multiple quantitative scales and in-depth interviews), which allowed for triangulation of data (Heale & Forbes, 2013). The PTSD and substance use scales alone were not enough to capture changes in PTSD symptoms and substance use over the course of the year; interview data was beneficial for helping understand changes in PTSD symptoms over time and how the SDs supported the veterans in managing their PTSD and allowed for better interpretation of the substance use scale scores. Ultimately, the two data sources complemented one another and captured a much more nuanced and in-depth understanding than on their own.

The small sample size, participant social desirability, habituation with multiple data collection points, and sponsor bias are all potential limitations to consider; but this study was exploratory in nature and designed to inform a larger forthcoming project. Additionally, these limitations were mitigated with data triangulation and employing data analysts outside of the project. Given that three of

the five participating veterans who provided a full year of data and were included in our analyses identified having Indigenous ancestry, this should be examined in future research given the harmful role of alcohol and currently opioids in the colonial history of Indigenous people in Canada. At the start and throughout data collection, the veterans were engaged in varying modes of treatment (e.g., prescription medications, therapy/counselling) to manage their PTSD symptoms, but wanted to explore the use of a SD as a complementary treatment practice. Future research may benefit from examining the potential confounding role of these additional treatment modes, as well as other physical and social health variables (e.g., chronic pain, family conflicts, etc.). Finally, it is important to keep in mind that SDs are a new field of study, and so these initial studies are serving as important starting points for future research.

FUTURE RESEARCH AND CONCLUSIONS

Next steps should include further exploration of how SDs assist veterans with managing PTSD symptoms and reducing problematic substance use. This could include data collected via interviews with spouses and friends of the veterans as well as the veterans' mental health professionals. Other data collection could include physiological data related to PTSD symptoms as well as amount of time spent together between the veterans and SDs to provide insights into their bond. It is also important to continue to explore, as adopted in this study, a POR approach that directs future research focus. The information gathered from this exploratory project will inform an upcoming Health Canada grant-funded project. Learning through this study that SDs are of some benefit to veterans diagnosed with PTSD is an important contribution to this emerging field.

NOTES

1 Métis people are those of mixed Indigenous and European ancestry (Library and Archives Canada, 2012).
2 First Nations replaced the term "Indian" in the 1970s and refers to Indigenous peoples of Canada who are neither Métis nor Inuit (Library and Archives Canada, 2012).

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COMPETING INTERESTS

The authors have no competing interests to declare.

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